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The Role of Nitrogen Gas and Variations of the Magnetic Field on the Characteristics of Flame on Combustion of Premixed Vegetable Oil Blends (B50)

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Abstract. This research examines the role of nitrogen gas, attractive and repulsive magnetics field for vegetable oil fuel, a mixture of coconut oil and jatropha (B50) on the characteristic and stability of the flame in the premix combustion process. The experiment was carried out in a cylindrical burner, mixed vegetable oil vapor was reacted with a mixture of air and nitrogen gas at various air fuel ratios. The results showed that the magnetic field increased the combustion speed because the electron spin became more energetic and the hydrogen proton spin changed from para to orto. The increase in combustion speed was greater in the magnetic field than without. Magnetic field attract exerted the strongest influence on increasing the burning speed and making the flame more stable. This happens, paramagnetic O_2 is pumped into the flame, while H_2O and N_2 as diamagnetic push heat out of the flame, causing faster combustion with an air-fuel ratio of 4.52 - 12.76. While the magnetic fields repel, H_2O and N_2 are attracted into the flame, however, O_2 is pumped out of the flame in the air-fuel ratio range of 4.52-15.1. Meanwhile, without a magnetic field, the air fuel ratios was 4.52-17.51 the highest compared to the magnetic field, produces poor combustion and is not ideal.

Keywords:-air-fuel-ratio; flame-evolution; magnetics-field; vegetable-oil; premix-combustion

INTRODUCTION

Rapid population growth and industrialization have led to a crisis of fossil fuel depletion and environmental degradation. Pollutants such as CO, CO_2, NOx, and organic matter emitted from burning fossil fuels reduces clean air quality. Therefore, alternative energy sources are the most attractive option to replace fossil fuels. Vegetable oils are a prospective alternative fuel because of its diesel-like properties and is produced from plants with minimal effort [1]. Jatropha, coconut, rapeseed, are some of the vegetable oils used in combustion engines [2]. Researchers have revealed that vegetable oils can reduce HC, CO, and CO_2. However, The main disadvantages of vegetable oils are: highly viscous, and lower volatility, affecting fuel atomization, evaporation and fuel-air mixing [3] including dirty filters and deposits in the engine [4]. There are various solutions proposed: blending, preheat and engine modifications. compression ignition engines use you right vegetable oil or mixed with diesel for operation. some researchers in various countries have succeeded in using a mixture of vegetable oil and diesel [5]. Various biodiesels have been tried as an alternative fuel [6]. It has been shown in all cases that better engine performance reduces smoke, hydrocarbons and carbon monoxide emissions, despite increased nitrogen oxides. Studied the performance characteristics of a multi-cylinder diesel engine using a mixture of 95% diesel fuel with 5% used cooking oil, palm, and coconut respectively, showed over there was a reduction in BP of 1.2%, and 0.7%, this was also a decrease in exhaust emissions including UHC, CO, and NOx [7]. From all of these studies, combustion stability largely establish engine fruition has not been investigated.

Furthermore, a study is required specifically regarding of nitrogen gas and direction of the magnetic fields in stabilizing combustion. This study provides a discussion of the role of nitrogen gas and the direction of the magnetic field in stability of flame behavior, and combustion characteristics. The application of flame stability is useful for the systematic and steady combustion furnaces and industrial burners during the long term.

MATERIALS AND METHOD

Vegetable Oil Fuel

The vegetable oils tested was a mixture of coconut oil and jatropha (B50). The compositions, physical, and chemical properties of the vegetable oils have been demonstrated in our previous study [8].

Experimental Apparatus

The experimental apparatus is shown schematically in Figure1. The fuel mixture of coconut oil and jatropha (B50) as much as 600 ml filled to boiler, after that it is heated by the stove to be evaporated at a temperature of 300 oC, and the pressure is kept constants at four bar. The fuel evaporating and nitrogen inlet valve is opened while the air inlet is closed. The next process is to slightly open the air inlet valve and the height difference is recorded in flow control. Differences in fuel and nitrogen flow control are recorded and kept constant Coconut and jatropha oils vapor is mixed with air and nitrogen in the combustion chamber. The reactant mix is passed to a nozzle for 18 mm of diameter, after that, the flame is lighted.

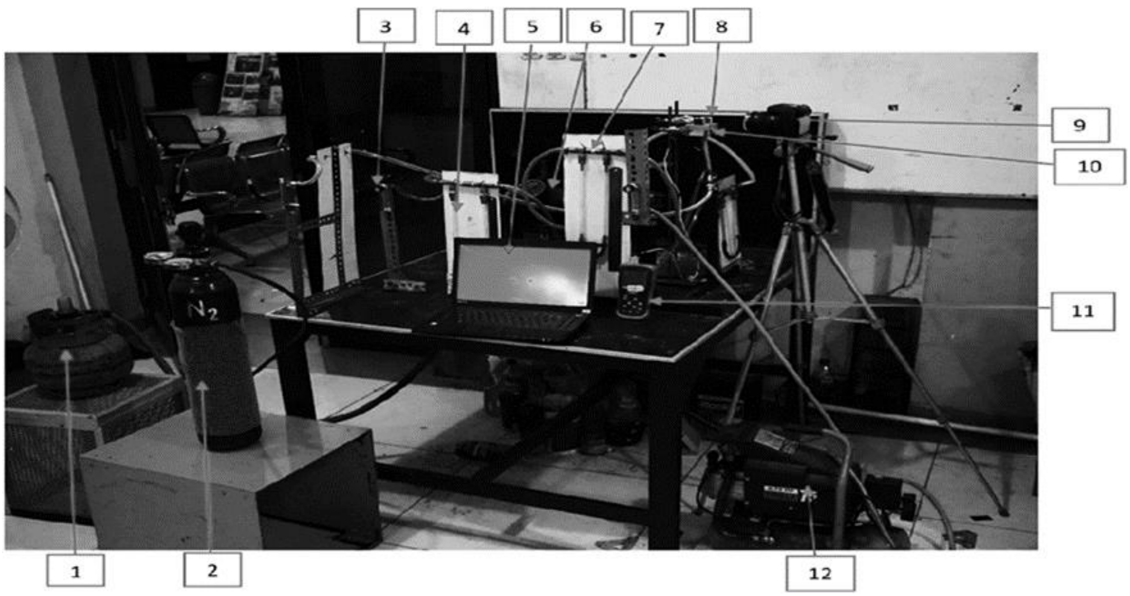

FIGURE 1. Experimental equipment; 1. stoves; 2. nitrogen gas; 3. flowmeter; 4. flowcontrol; 5. laptop; 6. boiler; 7. valve; 8. permanent magnet; 9. high speed camera; 10. burner; 11. thermocouple; 12. compressor

Thermocouple Position Schematic

Two rectangular magnets are placed on a stand made of aluminum plate and fastened for easy removal and re attachment changing the direction of the NN and SN magnetic fields. The image of the premix flame formed at the nozzle mouth taped before the flame was extinguished using a high-speed camera of 120 fps. The data logger is connected to a type K thermocouple placed at a position 2 mm above the burner tip to record the temperature generated in the computer memory as shown in Figure 2.

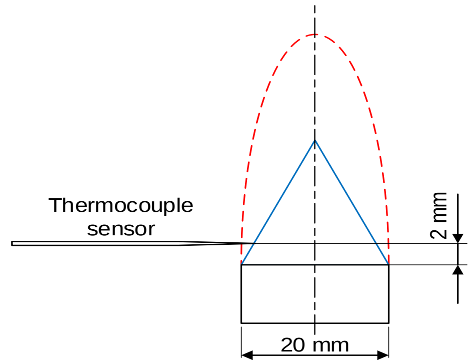

FIGURE 2. Thermocouple Position

RESULT AND DISCUSSION

Stability of the Flame at Various Air Fuel Ratio and the Orientation of Magnetic Field

It is shown in Figure 3 variations in the orientation of the magnetic field and nitrogen affect in stability, shape, and color of the flame at various air-fuel ratios in a mixture of coconut oil and castor oil (B50). Combustion of a mixture of coconut oil and jatropha (B50) without a magnet looks stable.

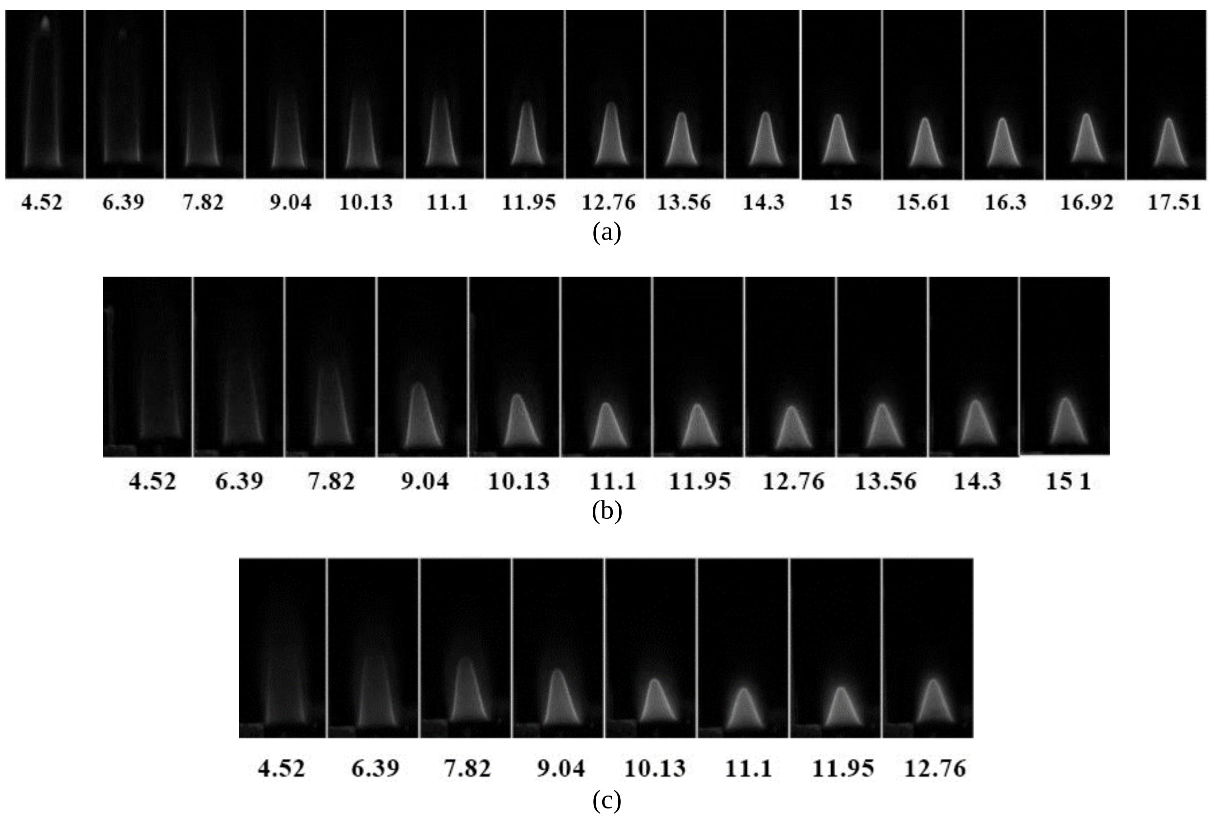

FIGURE 3. Stability and shape of flames various air fuel ratio and orientation of magnetic fields; (a) without; (b) repulsive; (c) attractive

The stability of the flame before the flame lifted off and then blew off occurred at an air fuel ratio of 17.51, while the shape of the flame was rather thin and the color of the resulting flame was ignited starting from an air fuel ratio of

11.95-17.51 shown in Figure 3a. The orientation of the repulsive and attractive magnetic fields affects the stability, this is indicated by the flame slightly wider and lighter at the air-fuel ratio of 15.1 and 12.76 before the flame is lifted and extinguished as shown in Fig.3a and 3b. This happens because O2 is a paramagnetic was moves in the magnetic field direction while the product H2O is diamagnetic carried heat [9]. The second, nitrogen as an inhibitor inhibits the collision of fuel vapors and air reactions. The stability and color of the flame are influenced by the shape of the vortex caused by the presence of a magnetic field, this phenomenon is caused by the north (N) and south (S) magnetic poles forming the Lorentz force. Causes the flame in the middle to be also dragged by the magnetic field so that the flame becomes turbulent. The flame was attracted towards the south magnetic pole because of positive ions (which is much more than the negative ions in the flame), while the negative ions were attracted to the north magnetic pole. The magnetic field pushes the nitrogen from the reactant fuel velocity, therefore the combustion without the nitrogen mixture becomes more perfect.

Temperatures at Various Air-Fuel Ratios and the Orientation of Magnetic Field

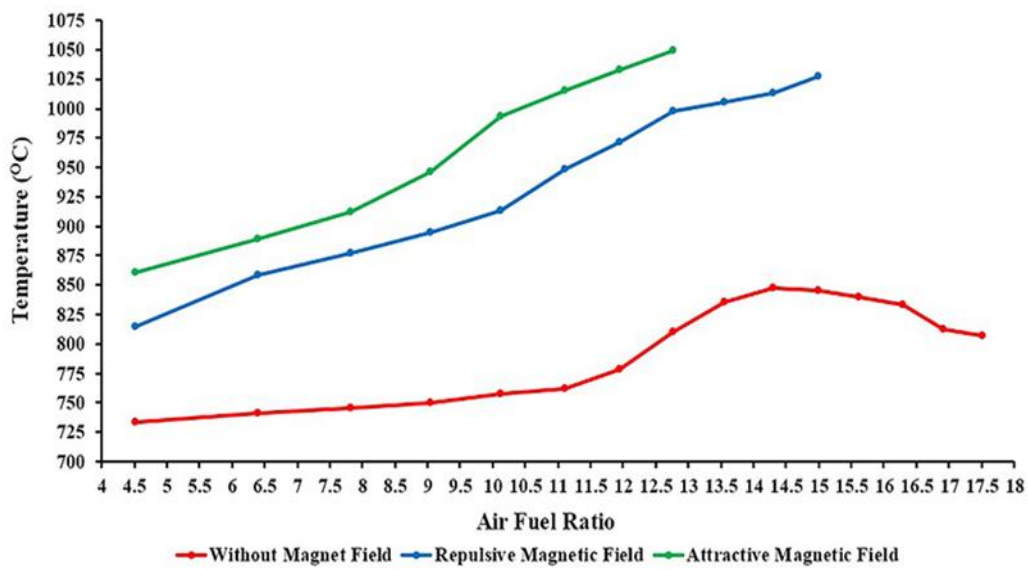

FIGURE 4. Temperature at various air fuel ratio and the orientation of magnetic field

Figure 4 shows the flame temperature of various variations of air-fuel ratio in a mixture of coconut oil and jatropha (B50) against two variations of magnetic and non magnetic fields and influenced by nitrogen gas. The highest burning flame was at an air fuel ratio of 12.76 with an attractive magnetic field of 1050 oC, followed by a repulsive magnetic field of 1028 oC at air-fuel ratio of 15, while the lowest temperature was 807 oC in an unmagnetized manner at an air fuel ratio of 14.3. The higher temperature indicates the premix fire caused by the calorific value of vegetable oil [8] and the increasing speed of combustion produces greater energy or power. The highest flame temperature occurs in an attractive magnetic field compared to a repulsive field or without a magnetic field.

Flame Height at Various Air-Fuel Ratio and the Orientation of Magnetic Field

Figure 5 shows the flame height of various variations of air-fuel ratio in a mixture of coconut oil and jatropha (B50) against two variations of magnetic and non-magnetic fields and influenced by nitrogen gas.

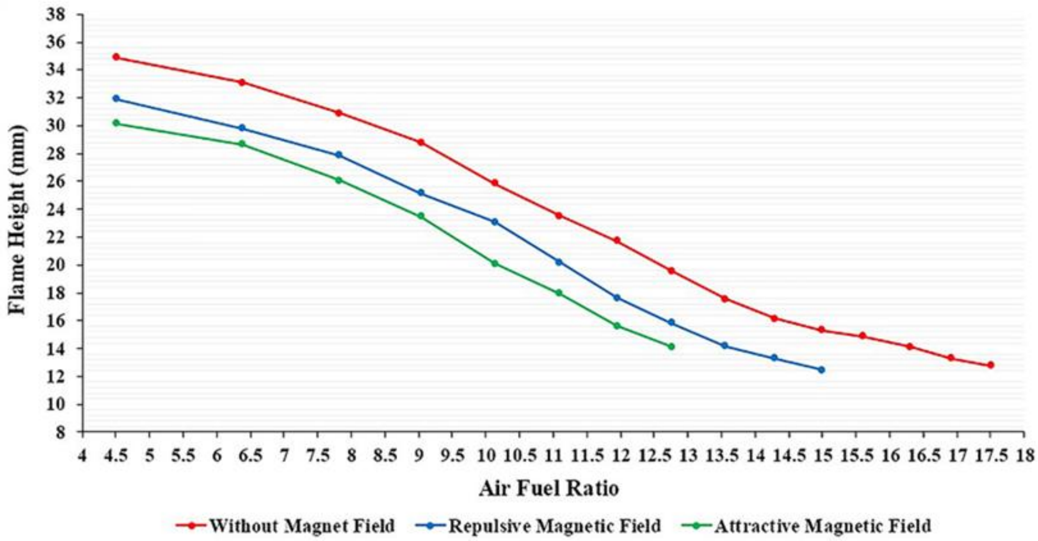

FIGURE 5. Flame height at various air fuel ratio and the orientation of magnetic field

The lower the air fuel ratio, the lower the flame height produced. The highest flame occurred in combustion without a magnetic field of 34.9 mm with an air fuel ratio of 4.52, then the flame height decreased successively at a repulsive magnetic field of 31.91 mm and an attractive magnetic field of 30.16 mm, where premix combustion in both conditions was very fast and short. This indicates that the repulsive and attractive magnetic fields are very reactive compared to those without a magnetic field, but the combustion is incomplete because there is some unburned fuel causing flame stability to be shorter (liftoff then blow off) occurs above the air fuel ratio of 15 in repulsive the magnetic fields and 12.76 attractive. The flame height gradually decreased as the applied magnetic field increases. when combustion has applied a magnetic field and nitrogen causes the flame to become smaller, foggy, and thinner. The possibility of an obstacle in the collision of fuel and air resulting in incomplete combustion. The decrease in flame height produced by premixed combustion follows an increase in the air-fuel ratio.

CONCLUSION

1. Magnetics field around the flame induces the airflow causing a change in flame height. Oxygen flows to the base of the flame on both sides result in increased concentration around the reaction zone. The fuel molecules react with the oxygen molecules causing better combustion with the formation of the inner and outer cones of a very short flame.
2. The use of nitrogen gas causes a decrease in convection heat loss as the strain increases.

However, this research still has shortcomings related to the amount of nitrogen gas concentration, types of vegetable oil and the intensity of the magnetic field which is not large. This is possible, the reduction in plantation areas that affects the amount of vegetable oil production in Indonesia tends to decrease, and the low strength of the magnetic field intensity affects the strength of the combustion characteristics. This study also cannot project the fuel efficiency, volumetric, thermal and polluting emissions of internal combustion engines. So it is necessary to conduct research that is more focused on its application to internal combustion engines for all types of pure vegetable oils and their derivatives, as well as the strength of the magnetic field intensity. So as to produce some data for the progress of the transportation sector.

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